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On the Correction of the Elements of Ceres.

By William Godward, Esq.

The Ephemerides of Ceres in the *Nautical Almanacs* from 1857 to 1881 have been derived from Schubert's Elements, published in No. 69 of Gould's *Astronomical Journal* (Cambridge, U. S., 1854, April 3). These elements were founded upon 14 normal places 1832-1853, taking account of perturbations by *Jupiter* only, the differential coefficients of which were furnished by Professors Encke and Wolfers, from the calculations for the *Berliner Jahrbuch.* With the corrections given by the solution of equations of condition for the times of the 14 normals, Schubert computed the corrected elements for 1854, January 0, Washington mean time, which are the foundation of the *Nautical Almanac* calculations to 1881.

From these elements, with the addition of perturbations by *Venus*, the Earth, *Mars*, *Jupiter*, and *Saturn*, approximately perturbed elements have been computed for periods of 2,412 days at intervals of 36 days, and used for obtaining the variations of the elements more accurately. At the end of each period the elements were corrected by the sums of the variations, and the corrected elements used for the variations for the next period. The total change in the elements having been thus determined, it was expected that the *Nautical Almanac* places would fairly represent observation.

The following Table of Errors, which are taken as referring to the nearest date for which a direct computation for the *Nautical Almanac* has been made, is formed from the observations at the Royal Observatory at Greenwich, and indicates that a correction of the elements is required.

		Cos $\delta . da$ ″	$d\delta$ ″
1857	February 27	+ 1·05	+ 4·29
1858	June 10	+ 24·44	− 0·28
1859	September 21	− 10·44	− 6·40
1861	January 13	− 31·93	− 15·85
1862	April 26	+ 3·55	+ 7·05
1864	November 5	− 36·36	− 24·76
1866	January 23	− 55·14	+ 3·68
1867	May 24	− 16·03	+ 13·28
1868	September 3	− 41·85	− 12·64
1869	November 9	− 77·01	− 37·66
1871	March 22	− 55·99	+ 30·64
1872	July 2	− 43·77	+ 10·67
1873	September 25	− 73·57	− 39·29
1875	January 24	− 107·89	− 22·92
1876	April 30	− 61·46	+ 38·07

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Equations of Condition.

Substituting their Logarithms for the Coefficients, and (*dn*) for 100 *dn*.

Right Ascension.

0 =	+0·02167	+0·25343 *dε*	−1·82727 (*dn*)	−9·42959 *dπ*	−9·07791 *dφ*	−8·74531 *dν*	+9·61091 *di*
0 =	+1·38815	+0·15866	−1·67341	+8·79309	+0·45026	+8·71883	+8·26269
0 =	−1·01880	+0·06763	−1·51698	+9·28063	−9·85385	−8·48159	+9·74006
0 =	−1·50417	+0·13935	−1·51390	−8·88258	−0·40945	+8·80257	−8·47363
0 =	+0·55082	+0·18784	−1·46086	−9·23279	+0·31537	+8·59062	+9·78662
0 =	−1·56059	+0·06328	−1·04516	+9·06618	−0·28573	+8·62961	+9·74328
0 =	−1·74145	+0·26956	−0·95626	−9·41007	−0·16827	−8·68744	+9·00651
0 =	−1·20496	+0·16748	−8·81601	−8·10106	+0·46585	+8·89115	+9·34380
0 =	−1·62167	+0·08108	+0·73824	+9·30775	−7·64933	−8·70851	+9·58870
0 =	−1·88653	+0·15478	+1·11607	−7·75740	−0·45428	+8·85327	+9·41996
0 =	−1·74809	+0·22490	+1·36820	−9·35468	+0·06218	−8·32243	+9·80386
0 =	−1·64113	+0·14550	+1·41454	+9·08732	+0·37980	+8·15594	−8·79560
0 =	−1·86670	+0·07492	+1·44078	+9·19673	−0·14660	−7·22272	+9·80866
0 =	−2·03298	+0·20767	+1·64983	−9·19207	−0·37592	+8·24304	−8·99167
0 =	−1·78857	+0·18405	+1·69760	−9·01030	+0·42486	+8·83916	+9·69184

Declination.

0 =	+0·63246	−9·69624 *dε*	+1·27768 (*dn*)	+8·87221 *dπ*	+9·36738 *dφ*	−8·97859 *dν*	+0·14955 *di*
0 =	−9·44716	−9·60969	+1·12470	−8·23502	−9·90172	−9·45291	+8·81178
0 =	−0·80618	+9·66285	−1·12072	+8·89691	−9·19385	+7·91116	−0·13094
0 =	−1·20003	+9·70228	−1·07136	−8·52930	−9·94969	−9·40821	+8·93490

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o =	+0·84819	−9·88424	+1·16443	+8·96774	−9·96629	+9·12824	+0·08078
o =	−1·39375	+9·75563	−0·75036	+8·80393	−9·95905	−9·13716	−0·03589
o =	+0·56585	−9·23843	+0·02674	+8·29688	+9·41652	−9·33933	+0·02312
o =	+1·12320	−9·78392	+9·10522	+7·98811	−0·07942	+9·41450	+9·72902
o =	−1·10175	+9·53698	+0·11943	+8·76664	+9·10233	+8·92758	−0·11871
o =	−1·57588	+9·76484	+0·71235	+7·68931	−0·06718	−9·38773	−9·80866
o =	+1·48629	−9·86102	−0·98924	+9·01481	−9·48451	+8·29070	+0·15899
o =	+1·02816	−9·31789	−0·59749	−8·33385	−9·51965	+9·43678	−9·62017
o =	−1·59428	+9·75783	+1·11470	+8·91566	−9·74813	−8·74013	−0·11989
o =	−1·36021	+9·48048	+0·93313	−8·54506	−9·54760	−9·40890	+9·76424
o =	+1·58058	−9·88245	−1·39200	+8·77685	−0·10034	+9·30107	+9·99529

Reducing by the method of least squares, the final equations are

o =	−3·00135	+1·56490 $d\epsilon$	−1·81720 (dn)	−0·08089 $d\pi$	+0·40170 $d\phi$	−9·79403 $d\nu$	+9·20734 di
o =	−4·15314	−1·81720	+4·27147	+0·93347	+1·15519	+0·22440	+0·26440
o =	+1·37076	−0·08089	+0·93347	+9·65020	−9·44460	−8·33700	−7·84111
o =	+2·73637	+0·40170	+1·15519	−9·44460	+1·85709	−8·77328	+9·52970
o =	+1·45517	−9·79403	+0·22440	−8·33700	−8·77328	+9·77366	+9·27225
o =	+1·69038	+9·20734	+0·26440	−7·84111	+9·52970	+9·27225	+1·25074

whence

$$d\epsilon = +29''\!\cdot\!26 + dn \times t \qquad di = -2''\!\cdot\!73$$

$$d\pi = +\ 3\cdot13 \qquad d\phi = -8\cdot76$$

$$d\nu = -19\cdot73 \qquad dn = +0\cdot00871$$

t being the number of days from 1867 May 24·0 G.M.T.

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RESIDUAL ERRORS.

		Equations.		Direct Calculation.	
		$\cos\delta \,.\, d\alpha$	$d\delta$	$\cos\delta \,.\, d\alpha$	$d\delta$
		″	″	″	″
1857	February 27	−4·8	+2·5	−4·8	+2·5
1858	June 10	−0·1	+0·6	−0·5	+0·6
1859	September 21	+1·1	+0·7	+1·1	+0·7
1861	January 13	+1·1	+1·1	+1·0	+1·3
1862	April 26	+2·4	−0·1	+2·3	−0·1
1864	November 5	+2·7	+0·8	+2·9	+0·8
1866	January 23	+4·2	−1·2	+4·3	−1·1
1867	May 24	−0·8	−0·4	−0·9	−0·3
1868	September 3	−1·2	−0·4	−1·2	−1·1
1869	November 9	−1·0	+0·6	−0·4	+0·7
1871	March 22	+1·3	−0·5	+1·4	−0·6
1872	July 2	−1·0	−0·3	−0·9	−0·1
1873	September 25	−3·7	−1·4	−4·0	−1·5
1875	January 24	−1·5	−0·1	−1·4	0·0
1876	April 30	+0·3	−1·1	+0·3	−1·4

The Centre of Gravity of the Apparent Disk of a Planet.

By Prof. Asaph Hall.

When a planet is observed from the Earth its disk will not be completely illuminated except at the time of opposition. At other times it will appear gibbous or crescent. If we assume the planet to be a sphere, which, according to the best observations is the case with *Mercury*, *Venus*, and *Mars*, the apparent disk will be composed of a semicircle and a semi-ellipse, which are separated by the line of cusps. If a right line be drawn through the centre of the line of cusps and at right angles to it, the centre of gravity of the apparent disk is in this line. In the plane triangle between the Sun, the Earth, and the planet, let ϕ be the angle at the planet, let a be the radius of the semicircular part of the disk, and denote by m the distance of the centre of gravity from the centre of the line of cusps. Then, when the planet is gibbous we shall have

$$m = \frac{8a}{3\pi} \sin^2 \tfrac{1}{2}\,\phi,$$